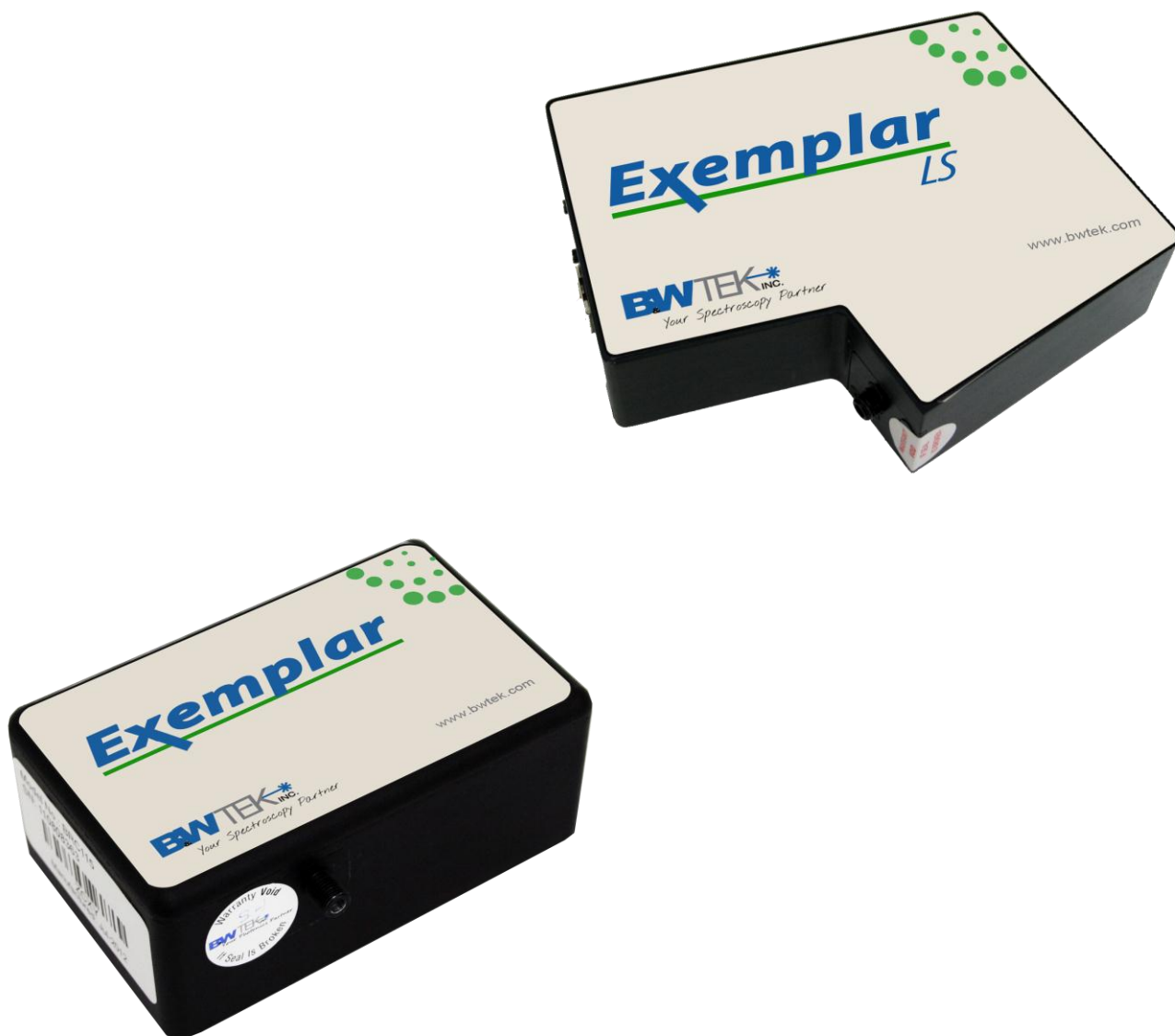


Exemplar™



Smart CCD Spectrometer User Manual

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Table of Contents

1. Introduction	3
2. Exemplar Spectral Acquisition Modes	3
2.1. Normal Scan Mode	3
2.2. Smart Scan Mode	3
2.3. Burst Scan Mode	4
3. Specifications	4
4. Check Contents	5
5. Installation	5
6. Operating Software BWSpec Quick Start Guide	6
6.1. Getting to know BWSpec graphic user interface	6
6.2. Quick Start	6
7. Auxiliary Port Function	7
8. Hardware Setup	8
8.1. Digital Input Section:	8
8.2. Temperature Monitor Section:	10
8.3. Analog Input Section:	11
8.4. Analog Output Section:	12
8.5. Digital Output Section:	13
8.6. Data Scan Mode Section:	14
Appendix A: Dimensional Drawing - BRC115E	18
Appendix B: Dimensional Drawing - BRC115U	19

1. Introduction

The Exemplar™ is the next step in the evolution of miniature CCD spectrometers. It is the first smart spectrometer featuring on board data processing, USB 3.0 communication, and temperature compensation. The Exemplar is also optimized for multi-channel operation featuring ultra-low trigger delay, ultra-low gate jitter, and super speed data transfer. Additionally, the Exemplar features a 2048 element detector, and built-in 16-bit digitizer with a >2.0 MHz readout speed.

2. Exemplar Spectral Acquisition Modes

There are three spectral acquisition modes as described below.

2.1. Normal Scan Mode

In this acquisition mode the spectrometer acquires data which is received by the PC/Software through the USB. The user can then perform post data manipulation such as Averaging, Smoothing and Dark Compensation. Continuous spectra acquisition is possible in Normal Scan Mode. At an integration time of 1.0ms the maximum frame rate is less than 500 spectra per second in this mode.

2.2. Smart Scan Mode

Smart Scan allows for data manipulation to take place in the Exemplar's on-board processor including Averaging, Smoothing and Dark Compensation, in that order. The user has the ability to send a command with flags for each of the methods. The internal data processing engine can handle any combination of these methods.

Table 1 details the frame rate at different combinations of methods at an integration time of 1ms.

Processing	Estimated Time Needed
Smoothing	23.5 (ms)
Dark Compensation	7.2 (ms)
Averaging N time	$T = 4.55(\text{ms}) \times N + 8.13 (\text{ms})$

2.3. Burst Scan Mode

This is the fastest spectral acquisition mode. After a burst mode spectral acquisition command is received, the internal spectral acquisition engine will continuously send the spectra back to the PC until the preset number of spectra is reached. In this mode the minimum integration time must be set to 1050us, as the events of signal integration and spectral readout plus sending of data are processed simultaneously. There is no time gap between the consecutive integration periods, which enables this spectrometer to be a suitable device for time-of-flight event capturing.

3. Specifications

See Product Data Sheets for specifications for the Exemplar Model BRC115E and BRC115U (Model LS)

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4. Check Contents

Before installation please check your system contents. They may include:

- Exemplar™ Spectrometer unit
- USB 3.0 Cable
- AUX Port Cable
- BWSpec4™ software CD



Exemplar™ Spectrometer



USB 3.0 Cable



BWSpec4™ Software CD



Aux Port Cable

5. Installation

Software / Hardware Installation

There is a BWSpec Installation Guide located on your software CD. Refer to this guide for full installation instructions

6. Operating Software BWSpec Quick Start Guide

6.1. Getting to know BWSpec graphic user interface

The BWSpec operating software has a graphic user interface which consists of a menu bar, quick access bar, graphic area, message bar and control panel.

Reference the BWSpec4™ User Manual located on your Software CD for more information on how the software works.

6.2. Quick Start

1. Run BWSpec from the shortcut icon that will have been placed on your desktop after installation.

2. From the toolbar, select “Acquire Continuously”



3. Aim the spectrometer's SMA Port (Light Input) towards a broadband light source; for example a tungsten bulb, light bulb, or overhead lights.

4. You should see a spectral response being displayed on the Graph in the BWSpec4™ software window, if not adjust (increase) the integration time from the toolbar.



Note: There are different ways in which light can be directed into the spectrometer's SMA Port and different light sources which can be used.

For more information on these types of setups, please visit our website: www.bwtek.com.

Multiplier Function

When using the Exemplar Spectrometer, the 'Multiplier' function is not available and will be greyed out:



7. Auxiliary Port Function

Exemplar is capable of monitoring and controlling both digital and analog signals through the Auxiliary Port on the side of the spectrometer. The table below is the description and function details for each pin of the Auxiliary Port. These standard functions are accessible through SDK. Moreover, if the customer wants to create their own input/output correlations, B&W Tek can configure a customized pin definition.

Pin	IO	Description	Comment
1	Input	Device Reset	Microcontroller hardware reset input and low level active. The minimum level low width is 1ms and minimum level high width is 5ms to guarantee proper reset function. Input high level 3.3V with internal 10k pull-up resistor.
2	Output	Digital Out 2	TTL OUTPUT 2. TTL 5V compatible, standard high level output current 20mA, standard low level input current 20mA.
3	Output	Digital Out 1	TTL OUTPUT 1. TTL 5V compatible, standard high level output current 20mA, standard low level input current 20mA.
4	Input	Digital In 2	TTL INPUT 2. TTL 5V compatible, standard high level input current 20mA, standard low level output current 20mA. Internal 10k pull-up resistor available.
5	Input	Digital In 1	TTL INPUT 1. TTL 5V compatible, standard high level input current 20mA, standard low level output current 20mA. . Internal 10k pull-up resistor available.
6	Input/output	Ground	Ground
7	Output	Analog Output	12 bit resolution DAC using resistor ladder method. The analog output range is 0~2.28V.
8	Input	External Trigger	External trigger pulse input. TTL 5V compatible. Falling edge effective. Recommended level low width is 30~100us. Internal 10k pull-up resistor available.
9	Input/output	Ground	Ground
10	Input	Analog Input	10 bit resolution ADC using successive approximation method. The analog input range is 0~2.28V.
11	Output	Digital Out 3	TTL OUTPUT 3. TTL 5V compatible, standard high level output current 20mA, standard low level input current 20mA.
12	Output	Digital Out 4	TTL OUTPUT 4. TTL 5V compatible, standard high level output current 20mA, standard low level input current 20mA.

8. Hardware Setup

The Exemplar allows for advanced hardware control features which can be found:

Menu Bar → Setup → Hardware Setup...

Click on the “BRC115 (Exemplar) Aux Port” tab

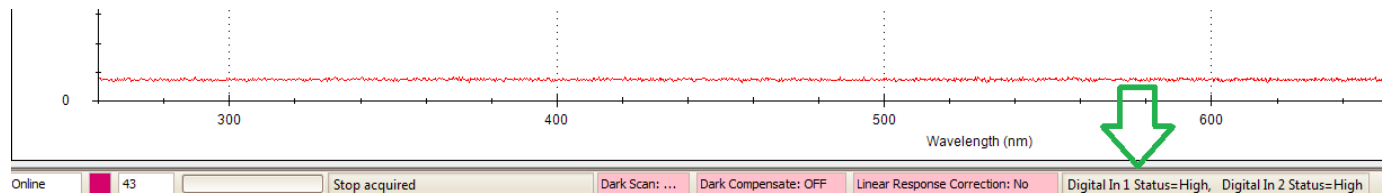
8.1.Digital Input Section:

The “**Get Status**” button will return a ‘High’ or ‘Low’ value depending on the TTL Digital Signal being applied to the ‘Digital In 1’ and ‘Digital In 2’ pins.

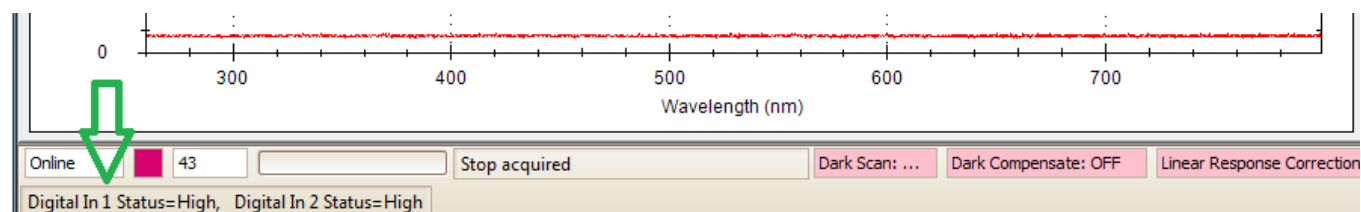
Monitor IO Pin After Scan: when enabled the Status of the ‘Digital In 1’ and ‘Digital In 2’ pins will be updated after each scan. The Digital In 1 Status and Digital In 2 Status will be displayed below the graph in the main BWSpec Window. Statuses will appear after the first acquisition. Location will vary depending on the size of the main BWSpec window.

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“Full Screen” Window display



“Reduced”/”Minimized” Window display



8.2. Temperature Monitor Section:

Hardware Setup

Common Setting BRC115 (Exemplar) AuxPort

Digital Input

Digital In 1 Status: Get Status

Digital In 2 Status: Get Status

☐ Monitor IO Pin After Scan Data

Data Scan Mode:

☒ Normal Data Scan

☐ Smart Data Scan

Temperature Monitor

Temperature(°C): Get Temp

Analog Input

ADC Value: Voltage(V): Get Value

Analog Output

DAC Value: 1000 Set Value

Digital Output

Digital Out 1

Name: Output 1

☐ Inverse

☐ Set to Low on DarkScan

☐ Set to High

Digital Out 2

Name: Output 2

☐ Inverse

☐ Set to Low on DarkScan

☐ Set to High

Digital Out 3

Name: Output 3

☐ Inverse

☐ Set to Low on DarkScan

☐ Set to High

Digital Out 4

Name: Output 4

☐ Inverse

☐ Set to Low on DarkScan

☐ Set to High

Close

The “**Get Temp**” button will return the Temperature of the PCB, which is also the CCD sensor reference temperature.

8.3. Analog Input Section:

Hardware Setup

Common Setting | BRC115 (Exemplar) AuxPort

Digital Input
 Digital In 1 Status: Get Status
 Digital In 2 Status: Get Status
☐ Monitor IO Pin After Scan Data

Temperature Monitor
 Temperature(°C): Get Temp

Analog Input (highlighted)
 ADC Value: Voltage(V): Get Value

Data Scan Mode:
☒ Normal Data Scan
☐ Smart Data Scan

Analog Output
 DAC Value: Set Value

Digital Output

Digital Out 1	Digital Out 2	Digital Out 3	Digital Out 4
Name: <input type="text"/>	Name: <input type="text"/>	Name: <input type="text"/>	Name: <input type="text"/>
<input type="checkbox"/> Inverse	<input type="checkbox"/> Inverse	<input type="checkbox"/> Inverse	<input type="checkbox"/> Inverse
<input type="checkbox"/> Set to Low on DarkScan	<input type="checkbox"/> Set to Low on DarkScan	<input type="checkbox"/> Set to Low on DarkScan	<input type="checkbox"/> Set to Low on DarkScan
<input type="checkbox"/> Set to High	<input type="checkbox"/> Set to High	<input type="checkbox"/> Set to High	<input type="checkbox"/> Set to High

Close

ADC Value: will return the Digital value of the Analog signal applied to the 'Analog Input' pin.
 $ADC\ Value = (Voltage / 2.28) * 1024$

Voltage (V): will return the Analog Voltage value of the Analog signal applied to the 'Analog Input' pin.
 $Voltage = (ADC\ Value / 1024) * 2.28$

(Reference the "Auxiliary Port Function" section in this User Manual)

8.4. Analog Output Section:

Hardware Setup

Common Setting BRC115 (Exemplar) AuxPort

Digital Input

Digital In 1 Status: Get Status

Digital In 2 Status: Get Status

☐ Monitor IO Pin After Scan Data

Temperature Monitor

Temperature(°C): Get Temp

Analog Input

ADC Value: Voltage(V): Get Value

Analog Output

DAC Value: Set Value

Digital Output

Digital Out 1

Name:

☐ Inverse

☐ Set to Low on DarkScan

☐ Set to High

Digital Out 2

Name:

☐ Inverse

☐ Set to Low on DarkScan

☐ Set to High

Digital Out 3

Name:

☐ Inverse

☐ Set to Low on DarkScan

☐ Set to High

Digital Out 4

Name:

☐ Inverse

☐ Set to Low on DarkScan

☐ Set to High

Close

DAC Value: can be set to a 12-bit Digital signal Range from 0 – 4095 when the ‘Set Value’ button is pressed. This will output a voltage range of 0 – 2.28 Volts to the ‘Analog Output’ pin.

$$\text{Voltage} = (\text{DAC Value} / 4096) * 2.28$$

(Reference the “Auxiliary Port Function” section in this User Manual)

8.5.Digital Output Section:

Hardware Setup

Common Setting: BRC115 (Exemplar) AuxPort

Digital Input

Digital In 1 Status: Get Status

Digital In 2 Status: Get Status

☐ Monitor IO Pin After Scan Data

Temperature Monitor

Temperature(°C): Get Temp

Data Scan Mode:

☒ Normal Data Scan

☐ Smart Data Scan

Analog Input

ADC Value: Voltage(V): Get Value

Analog Output

DAC Value: 1000 Set Value

Digital Output

Digital Out 1	Digital Out 2	Digital Out 3	Digital Out 4
Name: <input type="text"/> Output 1	Name: <input type="text"/> Output 2	Name: <input type="text"/> Output 3	Name: <input type="text"/> Output 4
<input type="checkbox"/> Inverse	<input type="checkbox"/> Inverse	<input type="checkbox"/> Inverse	<input type="checkbox"/> Inverse
<input type="checkbox"/> Set to Low on DarkScan	<input type="checkbox"/> Set to Low on DarkScan	<input type="checkbox"/> Set to Low on DarkScan	<input type="checkbox"/> Set to Low on DarkScan
<input type="checkbox"/> Set to High	<input type="checkbox"/> Set to High	<input type="checkbox"/> Set to High	<input type="checkbox"/> Set to High

Close

‘Digital Out 1’ – ‘Digital Out 4’ sections relate to the corresponding ‘Digital Out #’ pin on the Auxiliary Port.

(Reference the “Auxiliary Port Function” section in this User Manual)

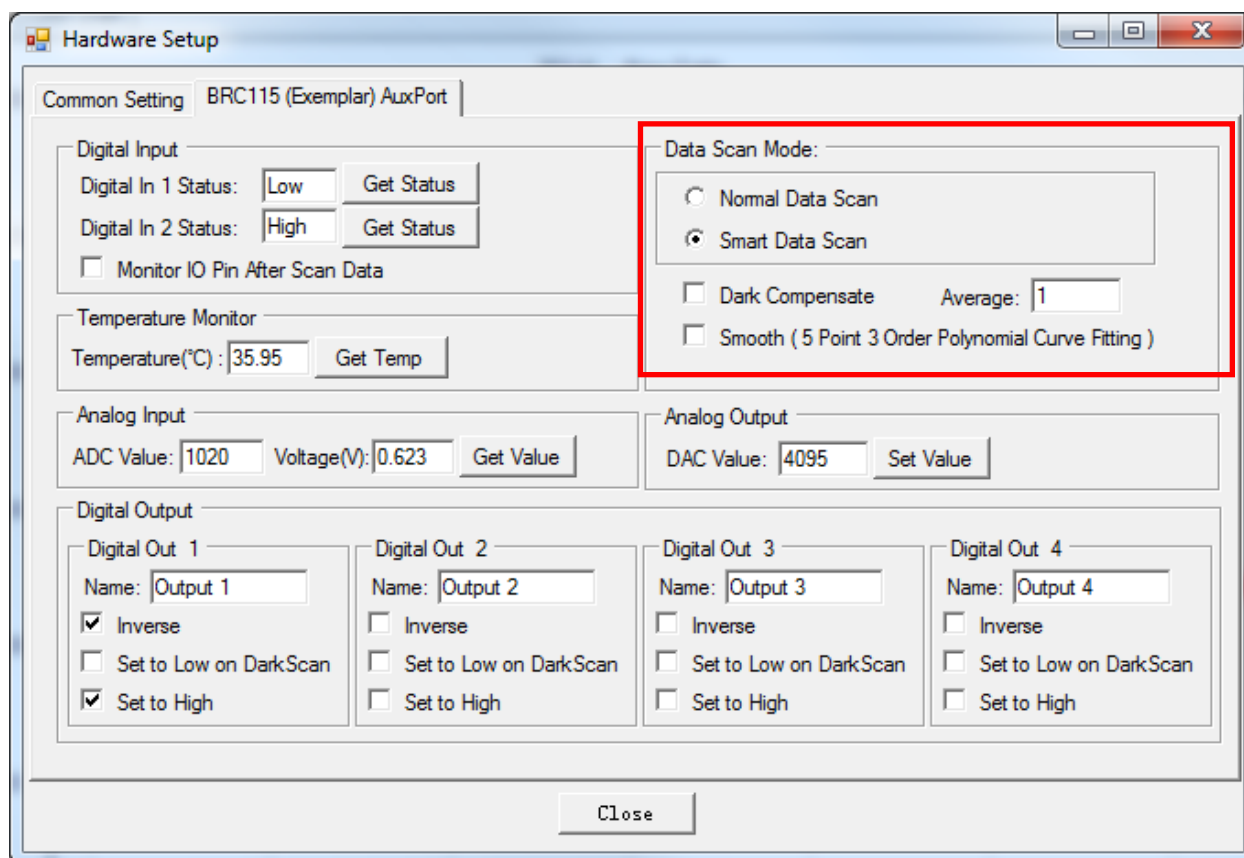
- **‘Name:’** field can be renamed to an application appropriate function, which will be displayed under the ‘Acquire Control’ section the BWSpec 4 Main Window.
- **Inverse Checkbox:** When activated, inverts the output status.
- **Set to Low on DarkScan:** This will Output the configured signal through the corresponding Digital Out Pin when a ‘Dark Scan’ is taken in BWSpec. (For Example, you could use this to Close an External Shutter)
- **Set to High:** By Default the Output Signals are set to LOW. When checked, the Output is set to HIGH through the corresponding Digital Out Pin. When enabled the checkbox status will also be reflected under the ‘Acquire Control’ section the BWSpec4 Main Window.

Reference the following ‘True Table’ for Output Signal configurations.

True Table:

Inverse Check Box	Set to High Check Box	Output (0 = LOW, 1 = HIGH)
0	0	0
0	1	1
1	0	1
1	1	0

8.6.Data Scan Mode Section:



The Exemplar has three data scan modes, **Normal Scan**, **Smart Scan** and **Burst Scan**.

8.6.1. Normal Data Scan

Normal Data Scan, when selected, allows the spectrometer to acquire and transmit data. Data manipulation is then accomplished on the software/computer. Averaging, Smoothing and Dark Compensate can be acquired and controlled for example.

8.6.2. Smart Data Scan:

Smart Data Scan, allows for data manipulation to take place inside the spectrometer allowing for smart spectra acquisition. Smart Scan Features are:

- Dark Compensate:** This will auto adjust the baseline of the spectrometer so that the dark current is auto removed from the collected data.
- Average:** You can run average scanning where x number of scans will be taken at the given integration time, and then the average of all these scans will be displayed in BWSpec
- Smooth:** Smoothing will be applied to all data outputted to BWSpec.

8.6.3. Burst Data Scan

Burst Mode allows for the fastest data acquisition possible by the spectrometer by limiting overhead processing from data transfer to the computer and saving data. In Burst Mode the spectrometer will continuously acquire and transfer data to the PC without a time gap between successive spectra.

Burst Mode is located under the Timeline Plugin:

•**Enable the Timeline Plugin-**

Menu Bar --> Plug-in --> Plug-in Manager...
Locate the "Timeline Plug-in" and enable the Check box.
Click "OK" to enable.

•**Open Timeline from the menu-**

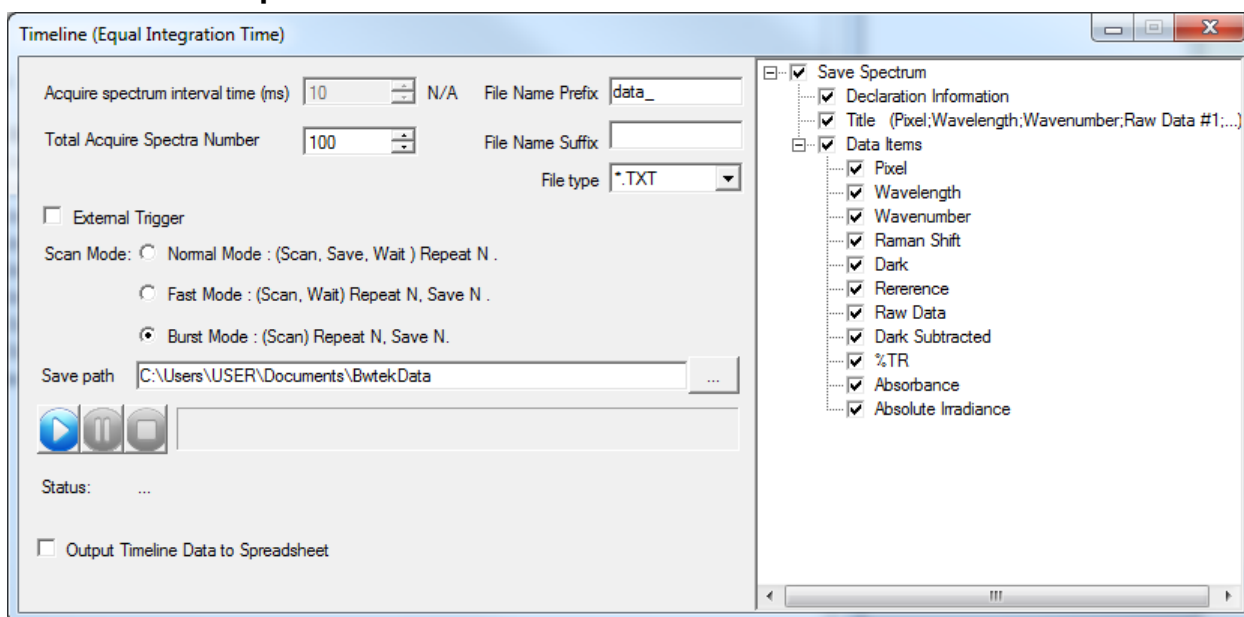
Menu Bar --> Tools --> Timeline --> Timeline (Equal Integration Time)...

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Notes:


- Burst Mode will only work with the Set integration Time $\geq 1050\mu\text{s}$, Multiplier = 1 and Averaging = 1 (1050 μs or 1.05ms is the minimum integration time allowed in Burst Mode). If the integration time is set to a lower setting, the integration time will be automatically updated to 1050 μs in Burst Data Scan.
- The highest number of scans the spectrometer can acquire is 16,000.
- Smart Data Scan cannot be used in conjunction with Burst Mode.
- “Time Average” from the Main BWSpec window will have No Effect when acquiring data.
- “Multiplier” from the Main BWSpec window will have No Effect when acquiring data.

8.6.3.1. Setup



- **Total Acquire Spectra Number:** This sets the number of scans to be performed by the spectrometer.
- **File Name Prefix:** This sets the prefix for the saved spectra
- **File Name Suffix:** This sets the suffix for the saved spectra
- **File type:** This sets the saved file type for the saved spectra.
Options: .txt, .csv, .BwRam, .SPC
- **Save path:** This sets the location where the data will be saved once complete.
- Right Side of the window allows the user to select what specific data is to be saved.

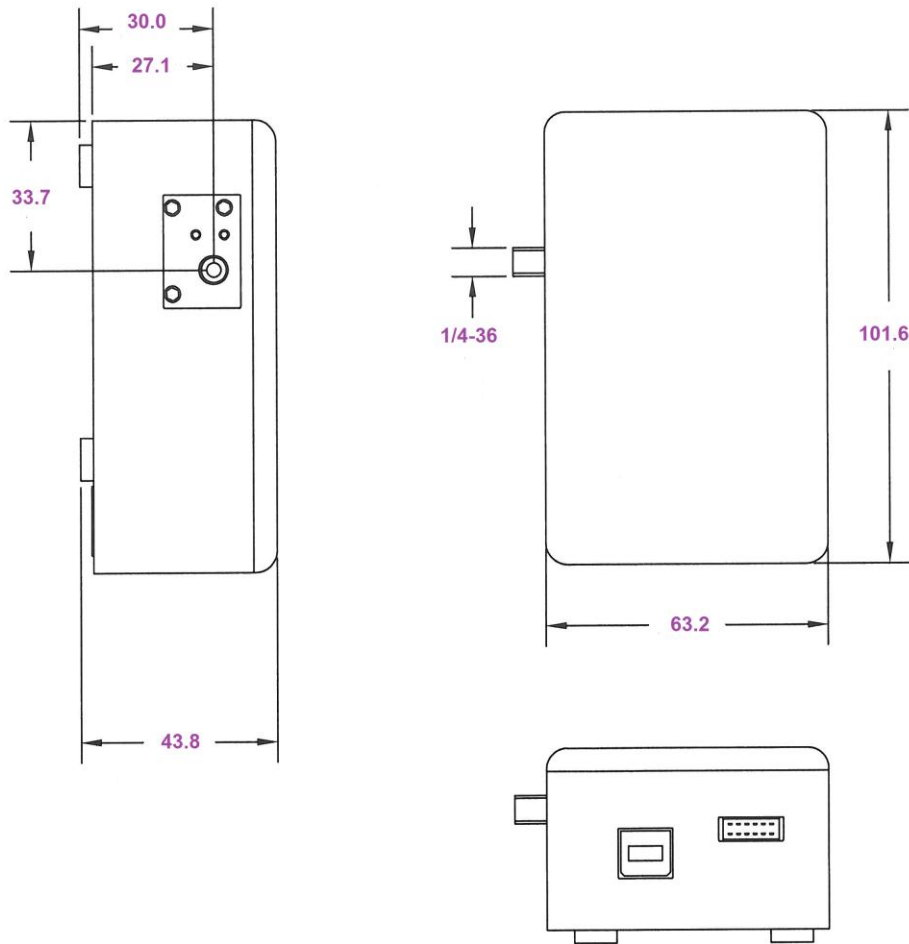
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-  These control the progress of the Burst Mode. Press the 'Play' button to begin acquiring.
- **Output Timeline Data to Spreadsheet:** This outputs the saved data to an Excel Spreadsheet.

Notes

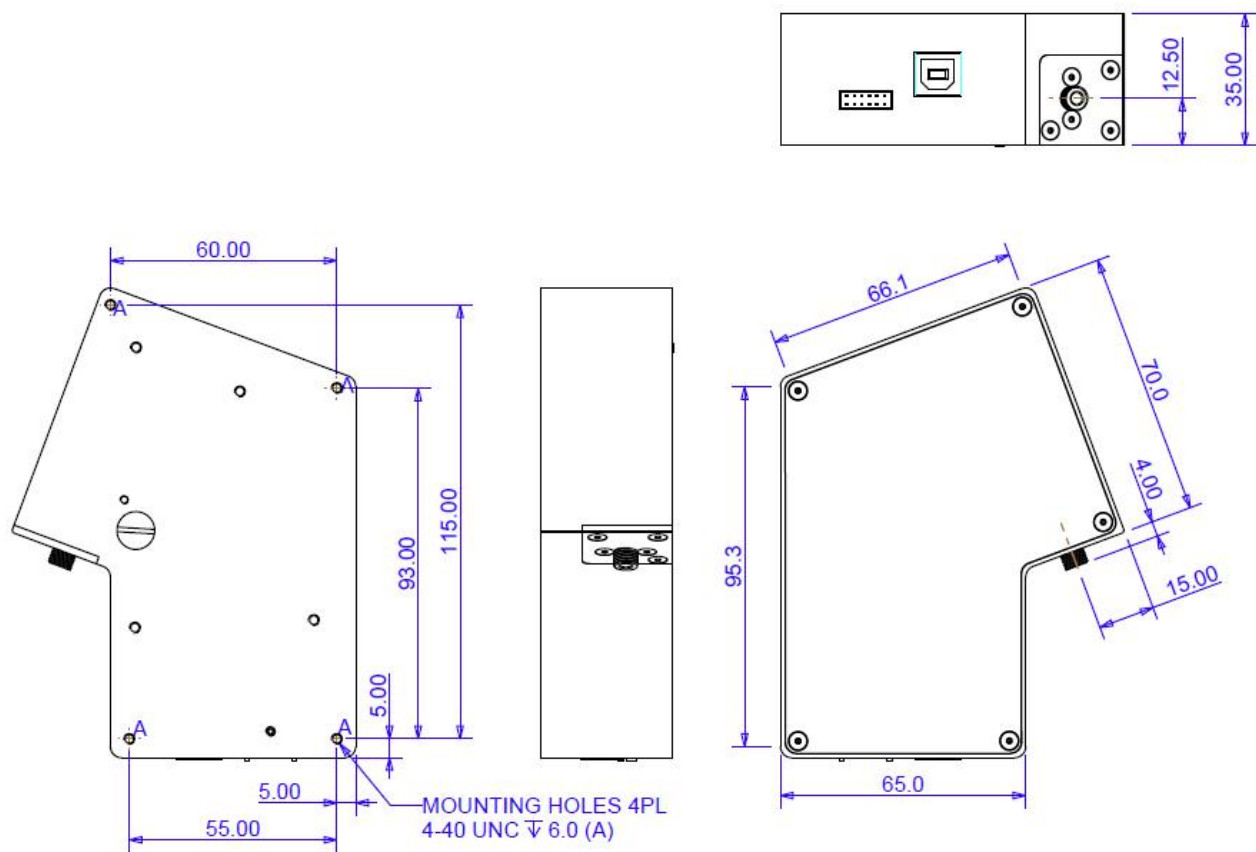
1. You must have **MS Excel** installed on your computer for this feature to work.
2. **DO NOT click** on the excel worksheet while it is being written. This will disrupt the output process and you will lose the data.
3. For Outputting to Excel, you are **limited by the Max number of columns (6)** for the number of scan you can have outputted.

Appendix A: Dimensional Drawing - BRC115E



Units are in millimeters (mm)

Appendix B: Dimensional Drawing - BRC115U



Units are in millimeters (mm)